

## ***Treatment of Congenital Unilateral First Brachymetatarsia With Computer-Assisted Hexapod External Fixator: Case Report***

### ***Konjenital 1. Brakiometatarsal Deformitenin Bilgisayar Destekli Hexapod External Fiksatorle Tedavisi: Olgu Sunumu***

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#### **Abstract**

**Introduction:** Brachymetatarsia is defined as shortening of the metatarsal. It can be congenital, iatrogenic or traumatic by growth plate damage. Fourth metatarsal is mainly involved, but any of the metatarsal can be affected. The incidence is 0.02% to 0.05%, with strong female predominance (F/M: 25/1). Impaired function and aesthetical problems are two major sources of distress. Uniplanar deformity correction may lead to several problems. In this case report, we aimed to present a unique case of symptomatic unilateral congenital brachymetatarsia of the first ray that was successfully treated with distraction osteogenesis via computer-assisted hexapod external fixator.

**Methods:** A 38 years-old female patient suffered from pain on first toe and difficulty in shoe wear for her right foot. After diagnosis of brachymetatarsia in the first ray, the patient was treated with lengthening by distraction osteogenesis via multiplanar external fixator.

**Results:** The fixator was removed at the end of 19<sup>th</sup> week, and the first metatarsal length of the patient's right foot was equal to that of the left foot. The length gain was 21 mm. At follow-up, the patient was free of pain and aesthetical concerns. She was able to step on foot with out discomfort.

**Discussion:** All deformity plans can be safely controlled with computer-assisted external fixators in brachymetatarsia cases, while multiplanar external fixators can also prevent sagittal plane deformities that can not be provided by single plane fixators.

**Keywords:** Bone-Lengthening/methods; External-fixationdevice; Metatarsal, Toes/abnormalities Patient's confirmation was done in this study.

#### **Öz**

**Giriş:** Brakiometatars metatarsın kısalığı olarak tanımlanan bir deformitedir. Konjenital, iatrojenik veya gelişme plağının travmatik hasarlanmasına bağlı oluşabilir. Başlıca 4. metatarsı kapsamakla beraber herhangi bir metatarsa etkilenebilir. Kadınlarda önemli derecede daha çok görülmekle beraber (K/E:25/1), insidansı %0.02-%0.05 arasındadır. Fonksiyonel bozukluk ve görüntü problemleri bu deformitenin sebep olduğu iki ana temel sorundur. Tek planda deformite düzeltmek bazı sorunlara yol açabilir. Bu çalışmada 1. metatars semptomatik konjenital unilateral brakiometatarsal deformitesi bilgisayar destekli hexapod eksternal fiksator yardımıyla distraksiyon osteogenezisi yapılarak başarılı bir şekilde tedavi edilen bir olguyu sunmayı amaçladık.

**Metodlar :** Sağ ayak 1. parmakta brakiometatars deformitesine bağlı ağrı ve ayakkabı giymekte güçlük şikayetleri olan 38 yaşındaki kadın hastaya bilgisayar destekli hexapod eksternal fiksator yardımıyla distraksiyon osteogenezisi uygulanarak uzatma tedavisi yapıldı.

Geliş Tarihi: 28/06/2019

Kabul Tarihi: 07/07/2019

**Sonuçlar:** Eksternal fiksator 19. Hafta sonunda çıkarıldığında sağ ayak 1. metatars uzunluğunun sol ayak 1. metatars uzunluğuna eşitlenmiş olduğu görüldü. Uzama miktarı 21 mm idi. Takiplerde hastanın ağrısının ve görüntü bozukluğuna bağlı endişelerinin kaybolduğu ve daha konforlu bir yürüme fonksiyonuna kavuştuğu gözlemlendi.

**Tartışma:** Brakiometatars olgularında bilgisayar destekli eksternal fiksator kullanılarak tüm planlardaki deformiteler güvenli bir şekilde kontrol edilebilir. Multiplanar eksternal fiksator , tek planlı eksternal fiksatorlerden farklı olarak sagittal plan deformitelerinin de kontrol ederek engelleyebilir.

**Anahtar Kelimeler:** Kemik uzatma/metodlar; Eksternal fiksasyon; Metatars anomalileri

Bu çalışmada hasta onamı alınmıştır.

### Introduction

Brachymetatarsia is a rare condition of the foot that's defined as any metatarsus being shorter than the proximal metatarsal parabolic arc by 5 mm or more (1). The incidence is 0.02% to 0.05%, with strong female predominance (F/M: 25/1). More than 50% of the cases have bilateral involvement (2). Early closure of the epiphyseal plate and growth retardation may play a role in etiology. It might be congenital, idiopathic, post-traumatic or secondary disease; such as pseudohypoparathyroidism, Down syndrome, Larsen syndrome, Albright hereditary osteodystrophy and Turner syndrome (1). Articulating phalanx hypoplasia, brachydactyly, and brachymetacarpia may accompany in that condition (1).

Symptoms of brachymetatarsia include pain, difficulty with shoe wear, and cosmetic concerns. Several surgical procedures have been described in the management of brachymetatarsia. Essentially, acute lengthening with internal fixation and gradual lengthening by distraction osteogenesis are the two main surgical options (2). Uniplanar external fixation may have some problems more such as union delay angulation, or early fusion in deformity correction, limb overgrowth and ultimate need for remanipulation. (2).

In this study, we present a unique case of symptomatic unilateral congenital brachymetatarsia of the first ray that was successfully treated with distraction osteogenesis via computer-assisted hexapod external fixator.

### Case Presentation

A 38 years-old female patient was admitted to hospital with the complaints of pain, difficulty in shoe wear and aesthetical problem due to shortness of first toe of her right foot. Patient's medical history indicated that she had a tendon transfer surgery on the 2nd, 3rd, 4th and 5th toes of her right foot due to hammer toe deformity 2 years ago. Any particular case was not noted in family history. Clinical examination revealed shortness in first ray of the right foot, and old incision scars of previous surgery on the other toes at dorsal side.

The patient's neurovascular examination yielded normal results. First toe joint movements were in full range. No hyperkeratotic lesions were observed in sole. Shortness of 1st metatarsus was defined (2,5 cm) in radiography (Figure 1). For surgical treatment, first metatarsus shaft osteotomy and lengthening with distraction osteogenesis via computer-assisted hexapod external fixator were planned for the patient.



**Figure 1:** Clinical and radiographic views of the right foot

### Surgical Technic

While the patient, under general anesthesia, laid in supine position, two 3-mm schanz screws were dorsomedially placed into the distal part of the first metatarsal. Then one 5/8 aluminum ring was fixated to schanz screws in a position perpendicular to the axis of the 1st metatarsus. After 3mm-schanz screw insertion to proximal part of 1st metatarsus and into medial cuneiform, one 5/8 aluminum ring was added to the proximal schanz screws, therefore setting up a hexapod computer-assisted external fixator (Spider Frame, Tasarımmed, Turkey). All rods were demounted after noting lengths of 6 telescopic rods. A 1-cm incision was made over dorsomedial side of the first metatarsus, and osteotomy was applied by the multiple drilling method without periosteal stripping. After fluoroscopic control of the osteotomy site, rods were set back to previous length. Finally, first MP joint was temporarily fixated percutaneously with 1.8mm K-wire in retrograde fashion (Figure 2).



**Figure 2:** Application of computer-assisted hexapod external fixator and early postoperative view

A 42-day patient prescription was formed based on 0.5mm daily lengthening towards the desired final length and the patient was taught how to do the procedure. Post-operatively, distraction was started on fifth day and concluded on the 42<sup>nd</sup> day. During this period all range of motion exercises except weightbearing were allowed for the patient. The length gain was 21 mm, percentage of lengthening was 51%, and the healing index was 2.1 month/cm.

Control X-rays were taken in weeks 3, 6 and 12. Upon observation of hard callus on week 19, the circular fixator and the K-wire in 1st MTF joint were removed under sedo-analgesia and a ROM walker was applied for two weeks. After removal of the brace, the patient progressively stepped on the foot with full weight. At the end of 21<sup>st</sup> week, the patient was able to step on her right foot without any pain and there was no restriction of movement at the 1st MTF joint. She was also satisfied with the aesthetical appearance (Figure 3).



**Figure 3:** Postoperative views after 3 years.

### Discussion

This unique case presented a safe method of first metatarsal lengthening by callotaxis via multiplanar external fixation in brachymetatarsia. Various surgical treatments have been described in brachymetatarsia to restore the normal the proximal metatarsal parabolic arc (1,2). Most commonly performed surgical procedures include single-stage metatarsal lengthening with bone graft (SSL) interposition and gradual lengthening (GL) by callotaxis via external fixation (3). Shorter period of union, better compliance and less scar formation are advantages of SSL. However, SSL options are not appropriate for patients needing length gain over 15mm due to the limited response of soft tissue to acute lengthening (1). In addition, infection and lack of incorporation in allografts, painful hardware and donor area morbidity in autografts are the disadvantages of the SSL.

On the other hand, GL allows time to surrounding soft tissue adaptation to lengthened bone. Since in our case the length gain was planned as 25mm, safe gradual lengthening was preferred with multiplanar control.

Literature indicates that rate of complications such as neurovascular complications, toe gangrene, cock up deformity, union delay, nonunion, malunion and refracture increases when the targeted length gain exceeds the initial metatarsus length by more than 40% (2). In our case, the gained length was 51% and we did not encounter such complication.

In callotaxis methods, consolidation time is longer compared to SSL procedures. Hwang et al. had higher healing index in first metatarsal when compared to fourth brachymetatarsia and proposed that larger osteotomised area and difference in weightbearing function of first and fourth metatarsal could be the reasons for longer consolidation time (3). Corticotomy without periosteal stripping may also affect the biology of consolidation. Choi et al. defined the healing index as 2.7cm/month for callotaxis group and 1.5 cm/month for SSL (2). In our case, we found this period 2.1 cm/month, which is shorter compared to literature.

Angulation problems in gradually lengthened segments constitute one of the major complications. Lack of sagittal plane control may be a predisposing factor on cavus deformity, subluxations in the MTF joint and lead to suffer from transverse metatarsalgia (4). Since the first metatarsal has nearly 30 degrees of inclination in the sagittal plane, uniplanar lengthening along the longitudinal axis will lead to displacement of metatarsal head towards plantar side, causing cavus deformity. To prevent cavus deformity with unilateral external fixation, Kim et al. performed dorsal closing wedge osteotomy on the middle shaft of the first metatarsal and additionally inserted K-wire from the tip of the distal phalanx through the metatarsophalangeal joint and the osteotomy site, making the first metatarsal parallel to the axis of the second metatarsal (4).

Frame breakage, failure of lengthening, callus fracture, early consolidation, pin tract infection may be encountered in lengthening with unilateral external fixation (4). These possibilities particularly increase when targeted length gain is more than 40% of the initial metatarsus length (2). Barbier et al. classified complications in gradual metatarsal lengthening and applied semicircular external fixation to decrease risk of severe complications during gradual lengthening of the first metatarsal (5). The spirit of external fixation emphasizes the importance of frame stability and multiplanar control of adjacent bony fragments via circular system.

Financial burden of metatarsal lengthening with distraction osteogenesis via computer assisted hexapod external fixator may be supposed to be higher at first glance. However, regarding the costs in management of complications encountered in other callotaxis methods, it may be reasonable and cost effective surgical option overall. Further reports and outcomes are needed with multiplanar fixation methods for comparison.

We believe that all deformity plans can be controlled with the computer-assisted hexapod external fixators we used in this case, while preventing sagittal plane deformities that may be caused by single plane fixators.

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